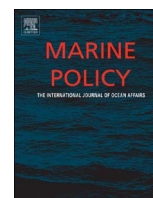




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Fisheries management approaches as platforms for climate change adaptation: Comparing theory and practice in Australian fisheries

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ABSTRACT

This study examines the extent to which the choice of management approach is a critical factor in enabling climate change adaptation in marine fisheries. Climate change is expected to compound many pressing issues affecting fisheries management. Good governance of fisheries, which is critical to building their adaptive capacity and social-ecological resilience, is seen as ever more important in the context of climate change. A range of fisheries management approaches have been developed and, to varying degrees, applied. Each has been described in the literature as a promising way to manage marine resources. Through literature reviews and a survey of practitioners, this study explores how theoretical properties of selected major management approaches (i.e., ecosystem-based management, adaptive management, co-management, adaptive co-management, and active adaptive management) enable climate change adaptation, and how such properties are perceived by practitioners to manifest in practice using an Australian marine fisheries context. Overall, the selected management approaches have the potential to enable climate change adaptation to varying degrees. Ecosystem-based management, in combination with adaptive management and co-management as nested management approaches, possesses the full array of adaptation capacities and attributes required for adaptation in fisheries. Distinctions between theory and practice observed in this study highlight the importance of practitioner perceptions and enabling institutional arrangements in adapting management to climate change.

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1. Introduction

As global climate changes as a result of increased greenhouse gases in the atmosphere, marine fisheries are being impacted by warming sea temperatures, sea-level rise, changing ocean currents, changes in nutrient supply and primary productivity, and the increased frequency and intensity of extreme climate and weather events [1,2]. These changes are also altering species composition, abundance and distribution [3–5]. Consequently, fisheries resources, and the stability of supply, access and utilization of those resources, are also being affected [6–8] with significant implications for dependent communities and industries, including requiring modification to fishing practices, livelihood

strategies and supply chains [9–11]. In sum, climate change is a major threat to the sustainability of marine fisheries, and is expected to exacerbate existing biophysical, social and economic pressures [12,13].

The impacts of climate change on fisheries need to be appreciated in the context of fisheries as social-ecological systems [14] and the linked societal drivers, such as changes in markets, technology and governance. Because of the dynamic and evolving context in which fisheries are embedded, it is likely that climate change will affect future fisheries systems differently [8,15] adding to uncertainty surrounding the effects of climate change on fisheries and management regimes. The dynamic nature of climate change adds to the challenges regarding the effectiveness and flexibility of management focusing on single species fisheries systems, single gear-type management controls, and conventional property-rights approaches [16–18].

There is a considerable volume of literature describing the need to enhance resilience and build adaptive capacity in marine

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fisheries [10,19–21], and associated management and governance attributes required in the face of climate change [22–28]. In this paper, *resilience* refers to the “amount of change a system can undergo and still retain the same function and structure while maintaining options to develop” [29]; and, *adaptive capacity* denotes “...the preconditions necessary to enable adaptation, including social and physical elements, and the ability to mobilise these elements” [30]. Theoretical analyses have emphasised the need to engender the required attributes through implementation of adaptive governance approaches informed by resilience thinking [30–35]. In contrast, embedding or “mainstreaming” the development of adaptive capacity within existing fisheries management systems has been seen as the more practical approach to addressing climate-driven changes [8]. As climate change is likely to exacerbate existing fisheries management problems [11], adaptation options need to be assessed within prevailing development contexts and governance goals [26,36–38].

Tension between normative and pragmatic considerations has highlighted the perceptions of practitioners as an important, but still little understood, variable affecting conceptualisation and operationalisation of resilience and adaptation [39–41]. Normative resilience-based management approaches have been critiqued for their grounding in ecological theory to the exclusion of practitioner experience [42], and considerations of utility and costs posed by substantive changes to management systems [19]. On the other hand, pragmatic public policy can significantly enable or constrain climate change adaptation in natural resource management [41,43,44].

What remains unclear is the means available to enhance fisheries adaptive capacity and resilience that would be more effective and timely in the face of climate change. Are development and implementation of new management approaches explicitly derived from resilience thinking required? Or, can resilience properties and adaptive capacity be embedded and enhanced in fisheries management approaches currently in use (for example, ecosystem-based management)?

A mixed-method approach is used to examine the suitability of resilience-based and best-practice management approaches as platforms for climate change adaptation in the context of Australia's marine fisheries. Five management approaches were selected for analysis. Two of these are derived from resilience thinking (i.e., adaptive co-management and active adaptive management), and have not yet been widely operationalised in practice [45,46]. The remaining three management approaches (i.e., co-management, adaptive management, and ecosystem-based management) are recognised as best-practice fisheries management [45–48], and have been operationalised and implemented extensively [49]. Literature describing the normative and theoretical properties of each of the management approaches was reviewed to identify and compare the degree to which they engender capacities identified as critical for adaptation in the context of climate change (e.g., building resilience and adaptive capacity). Attributes identified in the literature as requirements of management regimes conducive to climate change adaptation were then identified [8,22,23,25]. Practitioner perceptions of the selected management approaches were ascertained using a survey of senior fisheries managers to determine the presence or absence of adaptive attributes. The comparative suitability of the selected management approaches as platforms for climate change adaptation is examined, with particular considerations given to the role of practitioner perceptions. Concluding remarks on the implications of this study for fisheries management systems and for adaptation research are then outlined.

2. Background

2.1. Mainstreaming climate change adaptation in Australian fisheries management

Australia is currently regarded as being at the forefront of marine fisheries management [50,51]. Major reforms established in the early 1990s provide the basis for significant development in two related directions. The introduction of output controls in a wide range of fisheries with individual transferable quotas (ITQs) and harvest control rules (HCRs) have been matched by developing collaborative partnership approaches to co-management, and industry contributions to management through cost recovery principles. The establishment of iterative and adaptive management approaches has been facilitated by the development of tools such as management strategy evaluation (MSE) [52,53]. These fishery or species based approaches have been matched by increasing attention to the management of broader marine systems, including a focus on ecosystem approaches to fisheries [50–52,54]. Species-based approaches are being extended to encompass management of by-catch and, in some cases, habitat [55]. While a number of ecological and economic parameters are embedded, there has been more limited progress in including the social system in fisheries management [56]. There is, however, widespread recognition of the significance of social objectives in Australian fisheries management, and increasing concern with concepts such as a “social license to fish” [57].

Australian fisheries management reflects the country's federal political structure, with jurisdiction over Australian fisheries shared between federal, state and territory governments [58]. Federal government legislation has established statutory fishing rights, their registration and mechanisms for review of allocations, and mechanisms for allocation of permits and licences [59,60]. It has been federal government policy that ITQs are the preferred management tool in its fisheries since 1990, with many state fisheries also adopting quota management systems [61]. Industry has been responsible for 100 per cent of required attributed costs of management of federal government managed fisheries since 1994/95 [62]. Cost recovery approaches underpin a number of elements of the co-management approach including funding for scientific assessments and enhancing partnership approaches to management [53,63].

The reach of national-level environmental legislation to encompass fisheries management has been one of the most significant changes affecting Australian fisheries policy and management. More specifically, this has included the introduction of strategic assessment of fisheries for federal government managed fisheries and state export fisheries under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This assessment is made against a standard set of guidelines for the ecologically sustainable development (ESD) of fisheries [64]. In explicitly identifying target and limit reference points related to biomass, the development of a harvest strategy is significant, with harvest control rules being established as part of a formal management procedure [65].

The current state of practice of the selected management approaches varies across Australian marine fisheries (Table 1). As mentioned above, while there has been implementation of co-management, adaptive management and ecosystem-based management, there has been limited application of those management approaches informed by resilience thinking within Australia.

2.2. Role of management approaches in contributing to climate change adaptation in fisheries

In this study, management approaches determine the key

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